
The Linnaeus's Reed Snake, *Calamaria linnaei* Boie (Squamata: Colubridae: Calamariinae) from Ijen Plateau, East Java, Indonesia

Irvan Sidik^{1, 2*}, Sutiman B. Sumitro¹, Nia Kurniawan¹

¹ Department of Biology, Faculty of Mathematics and Natural Sciences, University of Brawijaya, Indonesia

² Laboratory of Herpetology, Zoology Division, Research Center for Biology, Indonesian Institute of Sciences – LIPI, Cibinong, Indonesia

Email address: i_sidik@yahoo.com

KEYWORDS

Calamaria
Biogeography
Morphology
Snake
Taxonomy

Abstract The decisive morphological character of *Calamaria linnaei* from the Ijen plateau was analyzed in an attempt to evaluate these snakes independently achieved as different populations or whether more likely only cryptic species affected by natural conditions. The evidence was concluded that a cryptic species is very interesting to be regarded as something entirely different. In general, however, the population appears to have more closely related to other congeners populations of the same species. It is suggested that at least temporarily, the *C. linnaei* population of the Ijen plateau be specifically considered to include in species with high individual variations based on limited geographic boundaries until molecular analysis proves it.

Introduction

The reed snake genus *Calamaria* have shared with neighboring countries through their distribution in biogeography zone. The highest country for species diversity of *Calamaria* in the world is Indonesia that representing with 41 species (<http://www.reptile-database.org>.) One's member of this genus is Linnaeus's reed snake (*Calamaria linnaei*) with limited zoogeographic distribution, until now so far the species is definitively known for certain on Java (Iskandar and Colijn, 2001). Several localities outside of Java such as Bangka have never been reconfirmed, and some specimens were collected from Borneo which been reported as *C. linnaei* mentioned Rooij (Rooij, 1917) and specimen collection by Meyer (Boulenger, 1894) in the locality from Sulawesi is very doubtful (Inger and Marx, 1965). However, this species is known to have a high diversity of morphological characters and seems showed considerable intraspecific variation. This circumstance firstly

was knew by Dumeril, Bibron and Dumeril in their book of the *Erpétologie générale ou Histoire Naturelle complète des Reptiles* in 1894 (Duméril et al., 1894). They had separated *C. linnaei* into several categories of body coloration after examined of live and preserved specimens. Over the century later, when Inger and Marx were observed *C. linnaei* especially from Cikajang, west of Java on the collections of the Rijksmuseum van Natuurlijke Historie (now under the name of Naturalis Biodiversity Center) Leiden, subsequently after examined dozens of an old specimen, they realized that this species had diverse morphological variations. Thereafter, they were able to establish the peculiarities of *C. linnaei* which was once named into several names as distinct species.

C. linnaei is a monophyletic species that has a complicated history of the systematic and evolution (Inger and Marx, 1965). In the attempt to recognize the morphology diversity of *C. linnaei* as systematically, they also displaced

status of several name species which were described from Java as synonyms, such as described by Reinwardt (*C. multipunctata*, *C. maculosa*, *C. reticulata*), others species such as, *C. versicolor* (Ranzani), *C. brevis* (Boulenger), *C. sondaica* (Barbour), *Changulia multipunctata* (Mertens) and several variations species of *C. linnaei* by Jan, namely as *C. linnaei* var. *tessellata*, *C. l.* var. *bilineata*, *C. l.* var. *transversalis*, *C. l.* var. *contaminata*, and *C. l.* var. *rhomboidea*. However, only one species has raised status from variety species of *C. linnaei* var. *melanota* by Jan become to species of *C. melanota*. This notation assumes that *C. linnaei* is a polymorphic may manifest as single species although originated from different locations in Java.

The morphological examination of the identified specimen that has resembled character will present an obvious picture of the diversity of this species. Moreover, a monophyletic group contain considerable genetic diversity and substructure, and may also represent species complexes (Maholtra and Thorpe, 2004). Nevertheless, significant confusion arises when measurement and scaling which mostly overlapping in number, despite having different color patterns. This complexity, in consequence, will give some doubt to researchers in determining descriptions while performing the examination. The condition emerges in case if without the support of the standard color patterns and details of the scalation. However, the geographical discovery of habitat-related dispersal patterns can contribute decipher the morphological problems of cryptic (Bickford et al., 2006) as occurs in this species. Nevertheless, we have examined as many characters as possible and analyzed, apparently the population of the Ijen plateau considers to be treated as isolated populations. The different amounts of morphological characters and color pattern somehow still require the further support of molecular analyses

to revealed in ensuring the identification of its lineages.

Materials and methods

The present paper is based on morphological data from the well-preserved specimen of *C. linnaei* from the Museum Zoologicum Bogoriense in Cibinong, Indonesia. Comparisons of external character states are based both on original descriptions, pertinent literature, and examination of museum specimens. We used terminology for morphological characters, scale counts and color pattern variations follow Duméril et al. (1854), Inger and Marx (1965), and other defined characters adapted from Orlov et al. (2010). The following measurements in mm (morphometric) and scale counts (meristic) were taken and abbreviated as follows: TL: total length; TaL: tail length from vent to tip; and TR: tail ratio: tail/total length. Other measurements were made with a dial caliper to the nearest 0.1 mm and used to calculate shield ratios: R: rostral width to height; RPf: rostral to the length of prefrontal suture; PfF: prefrontal to frontal length; FSu: width of frontal to supraocular; FP: frontal to parietal length. The qualitative of meristic characters: First scale of vertebral to others; Pro to Pto: height of preoculars to postoculars; Pto: dimension, width to height of postocular; SL: number of supralabials, composition and size; EMO: eye diameter to eye-mouth distance; Color pattern of first scale rows: Ven: number of ventral scale; SC: number of subcaudal scales; Dorsal color pattern; Ventral black marking; Tail color pattern both dorsum and underside. Due to insufficient data from central and eastern of Java, we refer the literature based on the observation by Inger and Marx (1965). The morphological characters this species has varied considerably, total 124 specimens have examined from 21 localities of four provinces that covering various specimens were collected in Java. We also performed a

comparison for further convincing to the type specimens, both species of reference as holotypes and other type specimens as synonymous which deposited on Naturalis Biodiversity Center, Leiden, Netherlands and Natural History Museum, London, UK. Specimens examined are listed in Appendix I and museum label abbreviations in Appendix II.

Results and discussion

Specimen description

The defining morphological characters of *C. linnaei* from Ijen plateau was analyzed in an attempt to confirm these specimens independently as distinguished populations or whether is more likely only a cryptic species. The

examined specimens are the old collections of MZB.Ophi.4792 and 4795-98 (5 adults) were collected by H. Lucht, January 1921 from the Ijen Plateau, Banyuwangi, East Java, Indonesia with an altitude range of about 950 - 1100 m (Figure 1). As is well known *C. linnaei* has a wide variety of morphologies. Therefore we described the differences by comparing of the Ijen specimens with *C. linnaei* from other regions of Java. We also incorporated several morphological characters on the subject related to the identification, because the specimens conform with almost all of the diagnostic characters into *C. linnaei*. The more detailed of the description presented through the physiognomy of the specimens, such as:

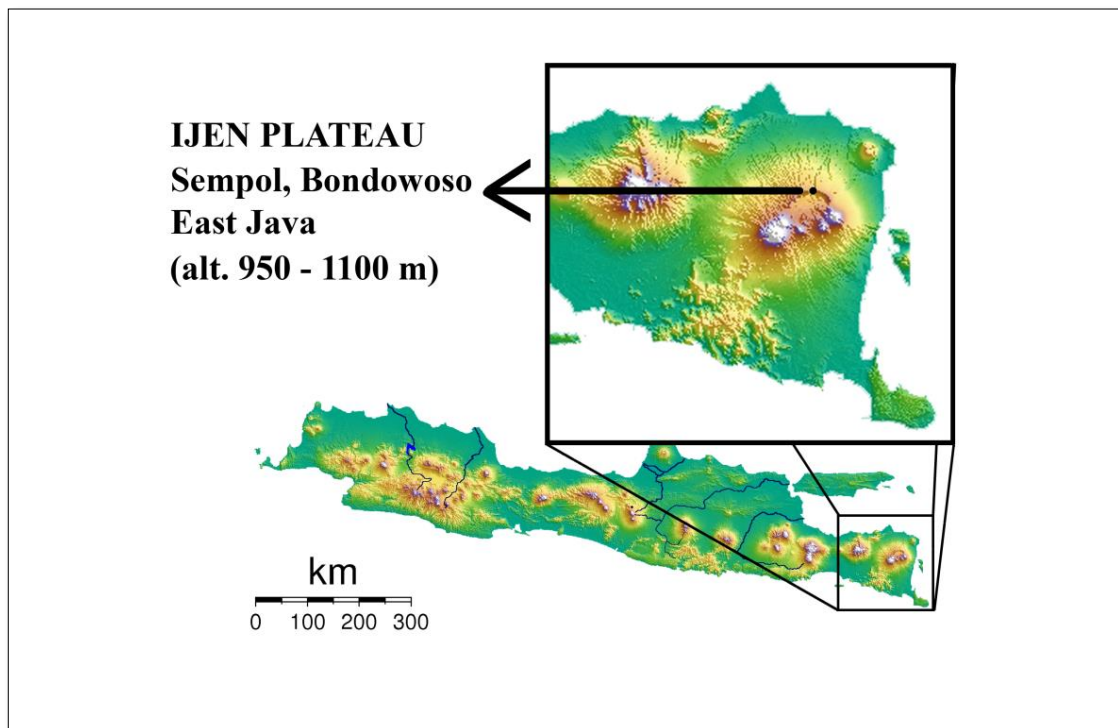


Figure 1. The location of the specimen (n = 5) was collected in the Ijen mountains, Bondowoso, East Java, Indonesia. As shown on the black dot.

Dorsal of body. The snake scales are formed by the differentiation of underlying skin or epidermis. Scales do not increase in number as for become mature nor reduce in number over time. The scales, however, grow larger and may change shape when ecdysis process. The prominent display as visible from above that is a short head with the same size as the neck, its body elongated small and cylindrical. The entire dorsal covered with smooth cycloid-shaped scales without apical

pits or keels. The scales usually have uniform size, vertebral scale row not enlarged but sometimes the first vertebral illustrates slightly contrast in measure than others. Along the row of the uppermost scales on dorsal of the body called vertebral scales. The entire vertebral are of the same in size and similar shape. Arrangements of scales are essential for taxonomic, no exception on the range number of dorsal scale rows. The Ijen specimens like common other species of the genus *Calamaria* has a dorsal scale on 13 rows around its the body. Although of head undistinguished from neck (habitus vermiform), however, head scales are essential characteristic features than another part of the body to distinguish interspecific as well intraspecific variations. Nine to ten modified maxillary teeth.

Ventral of the body. Intraspecific variations occurred in differences number of ventral and subcaudal from specimens examined. The Ijen specimens were compared to westward, central and eastward of Java are distinctly showed the differences numbers of ventral between males and females, although sometimes occurred overlapping in number, as follows: in males: 148 - 158 vs. 133 - 147 (westward); vs. 134 - 146 (central); vs. 140 - 149 (eastward) and females: 168 - 175 vs. 148 - 161 (westward); vs. 150 - 164

(central); 156 - 167 (eastward). The discrepancies in the number of ventrals indicate that this character is often used to determine the sexual dimorphism of snake species (Mebert, 2011). Comparison of subcaudal both in male and female between Ijen and other Javanese populations as follows, males, 16 - 19 vs. 15 - 19 (westward), vs. 17 - 22 (central), vs. 16 - 21 (eastward) and females, 8 - 12 vs. 7 - 12 (westward), vs. 9 - 13 (central), vs. 10 - 11 (eastward). Whereas the comparison of both sexes between Ijen and the population of *C. linnaei* originating from other regions in Java in terms of the mean (in mm) ratio of the tail to the total length, as follow: males, 0.0854 vs. 0.0863 (westward), vs. 0.0824 (central), vs. 0.0855 (eastward); females: 0.0432 vs. 0.0431 (westward), vs. 0.0414 (central), vs. 0.0432 (eastward). A small number of differences in subcaudals and ratio of tail to total length indicate intraspecific variations are occurring in local geography due to broad overlapping areas (Inger and Marx, 1965). The sexual difference of the morphological characters has proved that males have a longer tail and more subcaudal than females, on the contrary in a number of ventral, females have more than males (Table 1).

Table 1. Comparison of ventral, subcaudals and ratio tail to the total length between the population of *C. linnaei* from three regionals in Java and Ijen specimens. Abbreviations: M = male, F = female, Mean tail - total length in mm.

Regions in Java	Samples	Ventrals		Subcaudals		Mean tail – total length	
		M	F	M	F	M	F
Westward	66	133 - 147	148 - 161	15 - 19	7 - 12	0.0863	0.0431
Central	34	134 - 146	150 - 164	17 - 22	9 - 13	0.0824	0.0414
Eastward	19	140 - 149	156 - 167	16 - 21	10 - 11	0.0855	0.0426
Ijen plateau	5	145 - 158	168 - 175	16 - 19	8 - 12	0.0854	0.0432

Dorsum of head (Figure 2a): Rostral higher than its width, indented inside on the middle, the upper part is folded up to the muzzle, making it visible from above, equal to or slightly less than the length of prefrontal suture. Prefrontal shorter than frontal length, separated from orbit by preocular, touching to nasal and first two supralabials. Frontal hexagonal, an obtuse angle in front and a sharp rear, longer than wide, measured at the widest part is one and a half times wider than the supraocular and about shorter than length of parietal. Parietal about one and half times than prefrontal. Behind the middle curve of parietal is attached a large scale, elongated-cycloid form, surrounding by six scales and shields, it is named para parietal. The para parietal is touching to four dorsal scales, fifth supralabial and parietal.



Figure 2a. Dorsum of head the Ijen specimen.

Lateral of head (Figure 2b): Mouth is narrower not as wide as most other colubrids, and its gap to nape of neck. Nasal undivided with penetrating about the middle of the plate, oval shape and smaller than postocular. Preocular present, conical, less height than postocular. Postocular single, dimensions are comparing width and height: equal. Both oculars are not as high as the diameter of the eye. Eye located in the anterior third of the head, pupil rounded, small size compared to the height of the head. The diameter of eye less than eye to mouth distance. Supralabials are four; first longer than third, second and third entering orbit, fourth longest and largest; $4 (4 > 2 > 1 > 3)$. Infralabials are five, first scales pair not touching each other

unobstructed by mental plate, first two touching anterior genial, third contact both genial, fourth the largest, fifth about equal to second.



Figure 2b. Lateral of head the Ijen spesimen.

Venter of head (Figure 2c): On the underside of head located in anterior is triangular-shaped scale called the mental, which connected to first infralabials and stuck slightly into the gap between a pair of anterior genial. Afterward are successive two pairs of anterior and posterior genial. Both pairs lies in the central of throat region, which inner side of the anterior genial are entirely meeting in mental groove. The anterior genial more large than posterior and meeting each in the mental groove. Posterior genial usually only anterior half part is touching in the midline of mental groove. Three scales in series down the central region of throat on longitudinal line which touching directly to the posterior genial and ending with contact on the first ventral, are called gular. Sometimes a small scale (an azygous) is tucked between posterior genial that separates it and touch directly to anterior genial. Azygous occurred as single scale but also can an enlarge form of scale (Wareham, 2005). The occurrence of azygous scale was reported as the normal condition and position can be vary, on third of internasals in the hognose snakes (*Heterodon* spp.) (Dwight, 1983), may one or two small azygous shield between prefrontals and frontal in western keeled snake (*Pythonodipsas carinata*) (Schatti and McCarthy, 1987) or moderately of elongated single scale located between prefrontals in colubrine sea krait (*Laticauda colubrina*) (Leviton et al., 2014), which the presence or absence of this azygous scale can

used to determine sea krait species. An azygous of *C. linnaei* is a small scale and lies on the median between the posterior pair of genials behind the first three gulars. Four specimens of the twenty-four were examined from eastern Java have possessed azygous, the character appeared on two of Coban Talun and one each from Malang and Cangar.



Figure 2c. Venter of head the Ijen spesimen.

Tail (Figure 2d). The uppermost of tail usually with large longitudinal scales than others. At the posterior end of the ventral is a single anal plate and relatively broad in size. This scale that protects the cloaca that located on underside apart of the tail. Part of the body after anal is considered as a tail. The underneath of the tail consists of paired scales that next to each other, named as subcaudal scales. The reduction to four dorsal scale rows by second to tenth rows of subcaudals anterior to terminal shield. Tail shape relatively short tapering, terminated with a blunt tip.



Figure 2d. Lateral of tail the Ijen spesimen.

An early study on the information of sexual dimorphism, known by the scaled character was appeared to vary systematically between the sexes. The sex was predicted on the basis of scutellation and the snout-vent length (Dumeril et al., 1854; Boulenger, 1894). Therefore, five examined of preserved specimens was obtained from a detailed examination of the apparently sex-linked scale trait. The sex of each specimen was then determined by dissection and examination of hemipenis or gonads in order to verify the accuracy of the external scale character in diagnosing sex.

The Ijen specimens have specific dorsum of widest crossband pattern with higher number of ventrals both in males and females. The results from the striking color pattern shows that Ijen is not identical to other specimens of *C. linnaei*. As well as some numbers of contrast scaling count, we are in doubt putting the Ijen under of same scientific name. However, the Ijen as complement to redefined of the description for the status of this species. Therefore, populations originate from Ijen different from those of other locations and its located in the easternmost mountains of Java, as endemic population.

Color pattern

The specimens examined were in alcohol preservative but were still in excellent condition to be identified and revealed morphologically. The head is brown with dark mottled. Rostral, prefrontal, frontal and supraocular scales are darker than parietal. The base color of body is brownish to dark brown. The pattern of the dorsum is having a series of 16 - 19 crossbands just behind the head up to caudal. These crossbands are wide composed of one or three creamy scales regularly like-bar markings, distinctly bordered by dark-ebony scales crossed the back. We defined the color pattern of crossband as follow Peters (1964) with the comprehension of crossband is a transverse area of a color differing from the ground, crossing the vertebral line and extending down the sides to the ventrum, but not extending across the belly.

Between each crossband are bordered by three to eight dark brown scales on the vertebral line. The row of interrupted dark lines formed by black scales are present just behind the head. The fifth supralabial is half dark, remainder mostly dark on supralabial and infralabial sutures. Sometimes upper margin of supralabials resembles as a black stripe extending from snout to nape. The underside of head creamy or light with dark spots, especially in front of anterior genial; The light scales on the lateral behind of head appear like form a triangular shape. On the first scales row of the body with white spots consecutively forming as a dorsolateral lengthwise stripe which will reduce rearward before the anal plate. A single anal plate, with dark spots or entirely black. Subcaudals are paired, crisscrossed into two rows side by side. Usually two or three of caudal like-triangles extending upward almost across the dorsum of the tail.

The underside of the body is whitish or cream colored with varying amounts of black square pigment. The pigmentation square resembling a trapezoid or rectangle, may lie restricted only to the outer margin or in the center of ventral or both. The black squares approximately third or half ventral width giving a black checkered appearance. Only one specimen of MZB.Ophi.4797 has extreme entire black from first ventral to anal. The underside of the tail cream-colored with varying amounts of black scales, from a half, one-half to almost complete subcaudals of the tail. Tip of the tail is usually without patches of darkness.

The morphological characteristics of the color pattern can exist within the species more

than one causal trait (Bechtel, 1978). The statement is supported of our assumption that the variation in the color pattern of the Ijen population can be interpreted as having limited geographical distribution, thus causing polymorphisms effect in the dorsal pattern. This is due to the correlation between categories of color patterns in species of snakes as having stripes, uniform (plain) and non-stripe as well as regular-barred or blotches in terms of their definition as a protection mechanism from biotic dangers and defense strategies (Jackson, 1976). The explanation of the first two categories is the species have a rapid escape behavior than the last, because they do not have stay for self-protect mechanism and the non-stripe is the species of engaging in stationary, reasonably secure with the camouflaged state (Huey and Pianka, 1981). The possibility of our hypothesis is that the Ijen population is related to the ecological strategy of self-defense to determine the color pattern which is the result of the protection mechanisms and mimicry processes that influenced as an impact of environmental adaptation.

Comparisons

We performed a comparison of color pattern between Ijen population and several species as type specimens and their synonyms (Figure 3). All the characters correlated to the morphological, gives the figures that Ijen population has similar to one another and also differ from all other species shown in Table 2.



Figure 3a. Dorsum of Ijen Specimen



Figure 3b. Venter of Ijen Specimen



Figure 3c. Dorsum of Holotype *C. linnaei*



Figure 3d. Venter of Holotype *C. linnaei*



Figure 3e. Dorsum of Syntype *C. maculosa*



Figure 3f. Venter of Syntype *C. maculosa*



Figure 3g. Dorsum of Cotype *C. multipunctata*

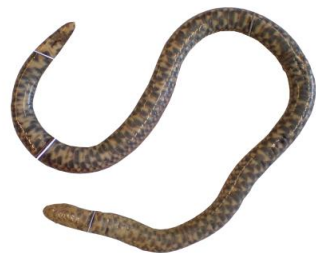


Figure 3h. Venter of Cotype *C. multipunctata*



Figure 3i. Dorsum of Holotype *C. reticulata*



Figure 3j. Venter of Holotype *C. reticulata*

Table 2. Comparison of main morphological characters between specimens of Ijen Plateau with Holotype of *C. linnaei*, and their synonyms.

Characters	Ijen Plateau (mean)	¹ <i>C. linnaei</i> (Holotype)	<i>C. maculosa</i> (Syntype)	<i>C. multipunctata</i> (Cotype)	² <i>C. brevis</i> (Holotype)	<i>C. reticulata</i> (Holotype)
R	higher than wide	higher than wide	wider than high	higher than wide	higher than wide	higher than wide
RPf	shorter	Shorter	shorter	shorter	equal	shorter
PfF	equal	Shorter	shorter	shorter	shorter	shorter
FSu	1.5 times	1.3 times	1.3 times	2 times	1.5 times	1.5 times
FP	shorter	Equal	shorter	equal	shorter	shorter
First vertebral	small	Equal	larger	small	-	equal
Pro to Pto	less	(uncounted)	same height	same height	same height	same height
Pto	equal	(uncounted)	higher	wider	equal	higher
SL	4 (4>2>1>3)	(uncounted)	4 (4>2>1>3)	4 (4>2>3>1)	4 (4>2>1=3)	4 (4>2>1=3)
EMo	smaller	Equal	equal	equal	greater	equal
First rows	not successively	not successively	continuously	continuously	continuously	continuously
Ven (males)	148 – 158	140	-	142	134	-
Ven (females)	169	-	147	151	-	160
Sc (males)	17 – 19	19	-	18	19	-
Sc (females)	10	-	10	10	-	10
TaL (males)	23.4	21	-	19.1	10	-
TaL (females)	13	-	12.8	10.6	-	12.2
TL (males)	256.5	243	-	221	125	-
TL (females)	332.2	-	284.4	235.4	-	278.6
Dorsal color pattern	widest crossbands	tight crossbands	widish crossbands	spots	dots	stripe-spots
Ventral black pigment	trapezoid-rectangles	Rectangles	rectangles	trapezoid-rectangles	spots	no
Tail-dorsum marking	crossbands	Blotches	blotch	spots	no	stripes
Tail-underside black pigment	rectangles-spots	Rectangles	rectangles-spots	rectangles-spots	few spots	no

Note: See materials and methods for abbreviations. (¹Uncounted means in column data the holotype of *C. linnaei* is characters in lateral head except eye cannot recognized because the specimen quite difficult to determine by damaged; ²The holotype specimen of *C. brevis* only accounted without photograph documentation).

Comparison of morphological characters between Ijen specimens with five comparable species, as follows: There are similarities in rostral size (except of *C. maculosa*), rostral length to prefrontal suture (except of *C. brevis*), width of frontal to supraocular (except of *C. linnaei*, *C. multipunctata* and *C. maculosa*), the ratio of frontal and parietal length (except of *C. linnaei* and *C. multipunctata*), and the ratio of size between postocular width and height (except of *C. multipunctata*, *C. maculosa* and *C. reticulata*). Differences of several characters of the Ijen specimens against five comparative species such as: prefrontal are the same size as the frontal, the first vertebral scales are smaller than the

paravertebral scales, and the preocular is shorter than postocular. The diameter of the eye is shorter than the perpendicular distance between eye to lower border of the supralabial. This can be interpreted that the orbital of the Ijen specimen is small or has small eyeballs. One characteristic of *C. linnaei* is the presence of the first scales row that has a white spot, forming white-stripes along the outer margins of the ventral and lateral bodies. The white-stripe on the Ijen specimen does not connect continuously or even without the stripe. The meristic in terms of the number of ventral both male and female more numerous, male of the Ijen: 148 - 158 vs. 140 (holotype of *C. linnaei*), vs. 142 (cotype of *C.*

multipunctata), vs. 134 (holotype of *C. brevis*), and female: 169 vs. 151 (cotype of *C. multipunctata*); vs. 147 (syntype of *C. maculosa*), vs. 160 (holotype of *C. reticulata*). However, the subcaudal scales of both the male and female of the Ijen specimens are relatively the same in number against the five species of comparison. While the color pattern of the dorsum and ventrum of the body and tail on the specimen Ijen, has obviously difference compared to the five species. We are unable to perform of comparison with *C. melanota* because the species has already clearly a distinct species though formerly as *C. linnaei* var. *melanota* (Boulenger, 1894) and previously belongs to the species complex of *C. linnaei*.

We presumed that by knowing both the differences and similarities in some morphological characters to comparable species, it is no longer leads as cryptic species but apparently a distinct species. On the other hand, identifying and describing suspect of cryptic species required further investigation with molecular analysis in order to solve the problem (Bickford, 2006). However, when species are consistently distinguished by one or more morphological differences, then presumably there is no gene flow between them. Assuming that any morphological differences have a genetic basis (Wiens, 2007).

In addition, the above statement gives us confidence as well that there is no prior reference to the distribution and even reveals the species of *C. linnaei* from the Ijen plateau. Previously, the ever-recorded distribution farthest eastward of Java was only from Tengger, which is a mountain range west of Ijen (Hodges, 1993). With regard to the formation of the geological history of Java, evidently, the eastern Java is not derived from a single unified island of Java. As the microplate comes from the north-west shelf of Australia and which moves northward in the Latest Jurassic age of about 155 Ma (Zahirovic et al., 2016). Moreover, the

southern mountains of East Java began in the Eocene Era (Granath et al., 2011). So, the mountains in the eastern Java region have long been formed in about 55 MYA. In fact, the species-level biodiversity of highland snakes, as currently known to have been arising essentially by tectonic events (Castoe et al., 2009). The fragmentation of mountainous habitat seemly is a significant factor in the process of speciation, dispersal, even the species extinction. However, it will ultimately participate in generating differences in the patterns of the species diversity. The results obtained here also indirectly highlight to the role played by natural history in explaining biodiversity.

Conclusions

An essential study in the context of the diversity patterns for species of snake with a limited ecological niche, in order to investigate of the morphological characteristic driven by natural factors at the fragmented highland of Java. Available data suggest that an adjacent pattern of distribution on the within species of *C. linnaei* play an essential role as a significant factor that had the broad effect on intraspecific variations. Given the substantial geographical barriers that effect to the cryptic species because of being isolated, then is resulting in plurality and this will be a different assumption when the ambiguity factor is no longer a problem.

Acknowledgements

We want to thank to P. Campbell and D. Gower from Natural History Museum in London, and E. Dondorp from Naturalis Biodiversity Center in Leiden for their generous having permit IS and NK examined of *Calamaria* collections. Therefore, we are very grateful to Syaripudin in assisting IS about the curatorial collection of *Calamaria* in MZB, and A. Hamidy who has spent much of his time discussing. Rechecking of location data in Ijen plateau, Sempol region, Bondowoso district, East Java can be done with USAID PEER Science Fund (sub-grant number: 200005017).

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- RMNH.RENA.29 – holotype of *C. reticulata*; RMNH.RENA.32 – syntypes of *C. maculosa* (2); RMNH.RENA.26 – cotypes *C. multimunctata* (3). Specimens of *C. linnaei* (n = 124): **Banten**. Ujung Kulon: MZB.Ophi.1075. **West Java**. Bogor: MZB.Ophi.415-16, 731, 733-35, 742, 756, 777, 949, 952, 965, 1106, 1203; Kebun Raya Bogor: MZB.Ophi.902, 979, 1093, 1098, 1356, 1436, 1439, 1443-44, 1667, 1713, 1739, 1993, 3825, 3832-33, 4790; Megamendung: MZB.Ophi.948; Cibodas: MZB.Ophi.753, 907, 972, 1262, 1357, 1395-96, 1479, 1714, 1727, 2044; Cibadak: MZB.Ophi.736; Cangkuang: MZB.Ophi.3794; Sukabumi: MZB.Ophi.998; Gunung Hejo: MZB.Ophi.847; Rajamandala: MZB.Ophi.849; Gunung Rakutak: MZB.Ophi.850; Bandung: MZB.Ophi.3834-47; Cileunca: MZB.Ophi.848. **Center Java**. Nusa Kambangan: MZB.Ophi.3534; Salatiga: ZMA.RENA.16366-67Pledung: MZB.Ophi.6095; Wonosobo (Tlogojati): RMNH.RENA.8620, 14488; Specimens without number register of RMNH.RENA from Mojotengah (12) and Jetis (9). **East Java**. Kediri: ZMA.RENA.16362; Tulung Agung: ZMA.RENA.16363; Malang: MZB.Ophi.920, 4788-89; Coban Talun: MZB.Ophi.5423-24; Cagar: MZB.Ophi.4492; Tengger (Nongkojajar): ZMA.RENA.16365 and specimens without number register of RMNH.RENA (7); Lumajang: RMNH.RENA.46515-16; Ijen plateau: MZB.Ophi.759-60, 3523, 4792-98.

Appendix II. Museum label abbreviations. MZB.Ophi: label of ophidian collection for Museum Zoologicum Bogoriense, Cibinong, Indonesia; NHM: The Natural History Museum, London, UK (formerly BMNH: British Museum and Natural History); RMNH.RENA: label of reptiles and amphibians collection for Naturalis Biodiversity Center, Leiden, Netherlands (formerly RMNH: The Rijksmuseum van Natuurlijke Historie); ZMA.RENA: label of zoology collection for Zoological Museum Amsterdam, Netherlands (ZMA collections are now deposited on Naturalis, Leiden).

Appendix

Appendix I. Specimens material used for examine of *C. linnaei* from 21 localities in Java with comparisons to type specimens.

NHM 1946.1.3.45 (BM 47.7.23.14) – holotype of *C. brevis*; RMNH.RENA.27 – holotype of *C. linnaei*;